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Effect of bio stimulant on yield and economics of Bt cotton hybrid and varieties under Vidarbha region

Dhote SS, Charjan YD, Kakade SU, Wankhade RS and PN Magre

Abstract
A field experiment was conducted at Cotton Research Unit, Dr. PDKV, Akola during *kharif* of 2021-22 and was laid out in Factorial Randomized Block Design (FRBD) design with two main plot treatments and four sub plot treatments.

The soil of experimental plot was vertisol, it was low in available nitrogen and organic carbon (0.37), medium in phosphorus, rich in available potassium and slightly alkaline in reaction (7.7). The cotton seed was sown at 90 x 30 cm spacing with 60:30:30 NPK kg/ha. The main plot treatments were two i.e. V_1 : PDKV JKAL-116 and V_2: AKH-9-5 (Suvarna shubhra) and sub plot treatments were four i.e. B_1: Bio stimulant (Anacardic acid) @ 4 mg litre^{-1} at 30, 45 and 60 DAS (20 mg+5 litre of water + 0.5 ml of DMSO), B_2: Bio stimulant (Anacardic acid) @ 4 mg litre^{-1} at 45, 60 and 75 DAS (20 mg+5 litre of water + 0.5 ml of DMSO), B_3: DMSO @ 100 µl litre^{-1} spray at 30, 45, 60 and 75 DAS (0.5 ml of DMSO+ 5 litre of water) and B_4: Control (water spray 30, 45, 60 and 75). Yield attributes and seed yield (kg ha^{-1}) *viz*., number of bolls picked plant^{-1}, average boll weights (g), seed cotton yield plant-1 (kg ha^{-1}) were recorded maximum in genotype V_1: PDKV JKAL-116 Bt (BG-II). The seed cotton yield was significantly highest in V_1: PDKV JKAL-116 Bt (BG-II) (2275 kg ha^{-1}) followed by V_2: AKH-9-5 (Suvarna shubhra) (1725 kg ha^{-1}). Same trend was observed in lint yield kg ha^{-1}, stalk yield kg ha^{-1} andharvest index. Significantly maximum Gross monetary return (Rs.137050) was registered in V_1: PDKV JKAL-116 Bt (BG-II) followed by V_2: AKH-9-5 (Suvarna shubhra) (Rs.103942) also the significantly maximum Net monetary return (Rs.82030) was observed in V_1: PDKV JKAL-116 Bt (BG-II) followed by V_2: AKH-9-5 (Suvarna shubhra) (Rs.53770) and B:C ratio was also highest (2.49) in V_1: PDKV JKAL-116 Bt (BG-II) over (2.07) in V_2 : AKH-9-5 (Suvarna shubhra). The seed cotton yield was significantly highest in treatment B_1: Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS (2256 kg ha^{-1}) which was at par with B_2: Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (2068 kg ha^{-1}). Same trend was observed in lint yield kg ha^{-1}, stalk yield kg ha^{-1} and harvest index.

Significantly maximum GMR (Rs.135908) was registered in B_1: Anacardic acid @ 4 mg/lit at 30, 45 and 60 DAS and lowest GMR was recorded in B_4: Water spray at 30, 45, 60 and 75 DAS (Rs.103269) also maximum NMR and B:C was also registered in B_1: Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 and lowest in B_4: Water spray at 30, 45, 60 and 75 DAS. Interaction effect of genotypes and application of different bio stimulant were found to be non-significant in respect of all parameter except yield.

Keywords: vertisol, Factorial Randomized Block Design, plot treatments

Introduction
Cotton (*Gossypium hirsutum* L.) also called as "white gold" and cotton fibre is the backbone of textile and other industries and plays a prominent role in the rural, national and international economy. It is grown mainly in tropical and subtropical region of more than 80 countries in the world. It is grown mostly for fibre used in the manufacture of cloths for mankind. Besides fibre, cotton is also valued for its oil (15-20 per cent) which are used as vegetable oil and cotton seed cake. Cotton seed cake used as cattle feed and can also be used as manure which contain 6.4, 2.9 and 2.2 per cent N, P and K, respectively also it is likely to play a pivotal role in paper, particle board and cardboard industries, With the advanced technology, short fibre or fuzz or lint can now be used to make excellent grade paper like currency paper, linoleum cellophane, rayons, photographic films, dynamic and moulded plastics. Cotton provides livelihood to more than 60 million people in India by way of support in agriculture, processing, and use of cotton in textile.

India is one of the largest producers of cotton in the world accounting for about 26 per cent of the world cotton production. The lint yield kg per hectare which is presently 487 kg ha^{-1} is still lower against the world average yield about 768 kg ha^{-1} which is 36.59 per cent higher than India average yield (Anonymous, 2020) [2].

Vidarbha shares 39.62 per cent area (15.08 lakh hectare) and 44 per cent of total production of Maharashtra with an average productivity of 300 kg ha^{-1}. Main reason for low productivity in Maharashtra and Vidarbha is most of the cotton production is under rainfed condition. Since time immoral, many attempts are going on to increase the yield potential of cotton crop through high yielding varieties, fertilizers and improved package of practices. Application of fertilizer alone has led to deterioration in health and productivity of arable soils, also the cost of chemical fertilizers is very high and unbalanced. Continuous use of chemical fertilizers is leading to a reduction in crop yield and results in imbalance of nutrients in the soil which has adverse effects on soil health and increase cost of cultivation. Hence, an attempt has been made to increase the growth and yield of cotton through the application of various bio stimulants.

Plant growth regulators are known to enhance the source sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops. Growth regulators can improve the physiological efficiency including photosynthetic ability and can enhance the effective partitioning of accumulates from source and sink in the field crops (Solamani *et al*., 2001) [18].

Bio stimulant helps to mitigate the impacts of water stress and benefit crops under water scarce condition. They are unique agrochemicals that, they must be absorbed by the plant tissue and transported to a reaction site before the desired response can be achieved (Du Jardin, 2015) [6]. Mostly they are applied as aqueous spray to a variety of plant surfaces. The total surface area and in particular, its surface chemistry and morphology are key factors in determining bio regulator dose that will be retained and hence available for penetration.

Dimethyl sulfoxide (DMSO) is a colourless, mobile, neutral, high boiling liquid that is miscible with water and with most common organic solvents. First synthesized in 1867. It now is commercially produced by utilizing the methyl groups of liquor from the kraft paper manufacturing process. This work showed that DMSO may aid in the absorption and translocation of herbicides following soil, injection, or foliar applications to maple trees. DMSO addition to soils caused a significant depression in soil pH which appears to be strongly linked to the uptake of Mn and P by bean plants (Norris and Freed, 1993) [11].

Bio stimulants are natural or synthetic substances that can be applied to seeds, plants, and soil. These substances cause changes in vital and structural processes in order to influence plant growth through improved tolerance to abiotic stresses and increase seed grain yield and quality. In addition, bio stimulants reduce the need for fertilizers, in small concentrations, these substances are enhancing nutrition efficiency, abiotic stress tolerance, crop quality traits, regardless efficient, of its nutrients content (Du Jardin. 2015) [6]. Bio stimulants offer a potentially novel approach for the regulation and/or modification of physiological processes in plants to stimulate growth, to mitigate stress induced limitations, and to increase yield. Bio stimulants based on humic substances have been studied in terms of stress protection against salinity due to their bio stimulatory activity (Aydin *et.al.* 2012) [3].

The effects of bio stimulants are still not clear. They can act on plant productivity as a direct response of plants or soils to the bio stimulant application or an indirect response of the bio stimulant on the soil and plant micro-biome with subsequent effects on plant productivity (Kumar *et al.* 1976). Several researches have been developed in order to evaluate the use of bio stimulants in improving plant growth subjected to abiotic stresses and finally the productivity.

Material and Methods

The present study was conceptualized and executed with the prime objective to study the effect of bio stimulant such as anacardic acid and dimethyl sulfoxide on yield and economics of cotton. The investigation was conducted during *kharif* season of 2021 at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. Number of various biostimulant like anacardic acid and dimethyl sulfoxide are being used on different crops at various concentrations and at different stages of development. The soil of experimental plot was vertisol black cotton soil it was clay (clay 55.12 per cent) in texture. Soil was slightly alkaline in reaction. As regard to fertility status, the soil was medium in available Nitrogen, low in available Phosphorus, fairly high in available Potassium, and moderate in organic carbon. Akola is situated in sub-tropical zone about 307.4 m above the mean sea level at the latitude of 22.42 degree North and the longitude of 77.02 degree East. The climate of the area is semi-arid characterized by three distinct seasons *viz*., summer, rainy, winter. The normal mean monthly maximum temperature is 42.6 ºC during the hottest month (May) while the normal mean monthly minimum temperature is 10.3 ºC in the coldest month (December). During the crop growing season, the maximum temperature ranged between 36.4 ºC during 27th MW (2.4 ºC higher than normal) to 27.2 ºC during 52nd MW (1.8 ºC lower than normal). The minimum temperature varied from 8.8 ºC during 51st MW (13.7 ºC lower than normal) to 26.2 ºC during 27th MW (1.6 ºC higher than normal).The mean daily evaporation reaches as high as 17.3 mm in the month of May and as low as 4.2 mm in the month of August. The mean wind velocity varies from 4.1 km hr-1 during October to 16.2 km hr^{-1} during June. Relative humidity attains the maximum value of 88% during the August season and the minimum 30% during May month. The amount of rainfall received during the cropping season was 1085 mm in 54 rainy days. During the crop season, the actual mean bright sunshine hours recorded were 5.3 hr which is 1 hr lesser than the normal mean of 6.3 hr. The highest BSH recorded with 8.9 hr during 43th MW (normal BSH of 8.2 hr during 43th MW) and the lowest with 1.4 hr during the 31st MW (normal BSH of 3.3 hr during 31st MW). The lower BSH facilitated improved the moisture use efficiency by the plant. During crop season the actual day time relative humidity was highest during 36th MW with 94% and it is lowest during 27th MW with 68%. The actual relative humidity during night time recorded its highest of 74% during 39st MW while the lowest of 29% during 51th MW. The mean actual relative humidity during both day and night time was found higher than the mean normal relative humidity.

Treatment details

Factor A: Variety

V_1: PDKV JKAL -116 (BG II)

V_2: AKH 9-5 (Suvarna Shubhra)

Factor B: Biostimulant

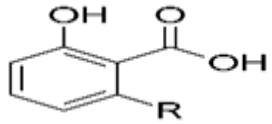
B_1: Bio stimulant (Anacardic acid) @4mg $litre^{-1}$ at 30, 45 and 60 DAS (20 mg+5 litre of water + 0.5 ml of DMSO).

B_2: Bio stimulant (Anacardic acid) @4mg $litre^{-1}$ at 45, 60 and

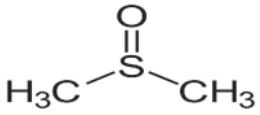
75 DAS (20 mg +5 litre of water + 0.5 ml of DMSO).
B_3: DMSO µl litre^{-1} spray at 30, 45, 60 and 75 DAS (0.5 ml of DMSO+ 5 litre of water)
B_4: Control (water spray 30, 45, 60 and 75).
The cotton crop was fertilized with the recommended dose of 60:30:30 NPK kg ha^{-1}. The source of nutrient used was by Urea, Single Super Phosphate (SSP) and Murate of Potash (MOP). Cotton was sprayed with different bio stimulants *viz*., Anacardic acid and Dimethyl sulfoxide using their specific concentrations at different days after sowing to study their effect on growth and productivity of cotton.

Anacardic acid
Anacardic acid is yellow liquid. It is partially miscible with ethanol and ether, but nearly immiscible with water it is found in the shell of cashew nut (*Anacardium occidentale*). Chemically, anacardic acid is a mixture of several closely related organic compounds. Each consists of a salicylic acid substituted with an alkyl chain that has 15 or 17 carbon atom and alkyl group may be saturated or unsaturated. (Rosen 1994).

Chemical Formula : $C_{22}H_{36}O_3$
Molecular Weight : 348.52 g mol^{-1}
Melting Point : 90 ^{0}C
Boiling Point : 474 ^{0}C
Structural Formula :



Dimethyl sulfoxide
Dimethyl sulfoxide (DMSO) is an organosulfur compound with the formula $(CH_3)_2SO$. This colorless liquid is an important polar aprotic solvent that dissolves both the polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water. It has a relatively high boiling point. (Thomas 1966)
IUPAC name : (Methanesulfinyl) methane
Chemical Formula : C_2H_6OS
Molar mass : 78.13 g mol^{-1}
Melting Point : 19 ^{0}C
Boiling Point : 189 ^{0}C
Structural Formula :



The inputs used in the present investigation, cost of cultivation was calculated by addition of all the cost incurred towards purchasing of inputs, cost incurred towards mechanical operations and the cost incurred on labour charges. Treatment wise cost of cultivation was worked out.
Statistically data was analyzed with Factorial Randomized Block Design programmed on computer by adopting standard statistical technique of analysis of variance (Gomez and Gomez, 1984) [8].

Results and Discussion
The numbered picked boll plant^{-1}, average boll weight (g) and seed cotton yield plant^{-1}were presented in Table 1.

Table 1: Number of picked bolls plant^{-1}, average boll weight (g) and seed cotton yield plant^{-1} (g) of cotton as influenced by different treatments

Treatment	Number of picked boll plant^{-1}	Average boll weight (g)	Seed cotton yield plant^{-1} (g)
Factor A–(Variety)			
V_1 : PDKV JKAL- 116 (BG-II)	26.33	5.03	136.01
V_2 : AKH 9-5 (Suvarna Shubhra)	21.33	4.41	102.54
SE(m) ±	0.41	0.10	2.22
CD at 5%	1.24	0.30	6.73
Factor B–(Application of bio stimulants)			
B_1 : Anacardic acid @ 4mg litre^{-1} at 30,45 and 60 DAS	25.22	4.98	132.36
B_2 : Anacardic acid @ 4mg litre^{-1} at 45, 60 and 75 DAS	21.02	4.73	107.97
B_3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	18.37	4.65	92.85
B_4 : Water spray at 30, 45, 60 and 75 DAS	16.70	4.52	81.86
SE (m) ±	0.58	0.14	3.14
CD 5%	1.76	NS	9.52
Interaction (A X B)			
SE (m) ±	0.82	0.20	4.44
CD 5%	2.49	NS	13.47
GM	21.38	4.77	108.93

Effect of Variety
The numbered of picked boll plant^{-1}, average boll weight (g) and seed cotton yield plant^{-1} was significantly influenced due to different variety at, harvest. However, average boll weight was found non–significant with respect to bio-stimulant treatment and under interaction.
Significantly highest number of picked bolls plant^{-1} *i.e* 26.33 was recorded in Variety V_1 *i.e* PDKV JKAL–116 than V_2 *i.e* AKH 9-5 (Suvarna Shubhra) 21.33. As there was more number of fruiting branches in Bt cotton hybrid than improved variety number of picked bolls plant^{-1} was also more. Average boll weight was found significantly superior in genotype V_1 i.e PDKV JKAL–116) than genotype V_2 *i.e* AKH 9-5 (Suavarna Shubhra). Higher boll weight (5.03 g) was recorded in this genotype as compared to (4.41 g) in AKH-9-5. Significant difference in boll weight may be due to the varietal character. Seed cotton yield plant^{-1} was found significantly superior in genotype V_1 *i.e* PDKV JKAL–116 than genotype V_2 *i.e* AKH 9-5 (Suavarna Shubhra). Highest seed cotton yield (136.01 g) was recorded in this genotype as compared to (102.54 g) in AKH-9-5. The higher seed cotton yield in PDKV JKAL–116 might be due to genetic yield potential of Bt hybrid compared to improved variety.

Effect of bio stimulant
Number of picked bolls plant^{-1} was significantly affected by spray of various bio stimulants treatment B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30,45 and 60 DAS was found

significantly superior over all other treatment and recorded highest number of picked bolls plant^{-1} *i.e* 25.22) fallowed by B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS *i.e* 21.02 and then B_3 *i.e* DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS 18.37 lowest number of picked bolls plant^{-1} were observed in treatment B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS *i.e* 16.70. These might be due to the presence of more number of flowers whereby allowing more number of flowers to be pollinated and retained by the plant. This might be positive result of application of plant growth regulators treatment. This findings are vicinity of those reported by Gadakh *et al*. (1992) Singh *et al.* (1997) and Basbag (2008) [7, 17, 4]. Difference in average boll weight due to various treatments of bio stimulants could not reach up to the level of significance. However average boll weight of seed cotton was (4.77 g). Seed cotton yield plant^{-1} was significantly affected by spray of various bio stimulants treatment B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30,45 and 60 DAS was found significantly superior over all other treatment and recorded higher seed cotton yield plant^{-1} (132.36 g) fallowed by B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (107.97 g) and then B_3 *i.e* DMSO 100 litre^{-1} at 30, 45, 60 and 75 DAS (92.85 g) lowest seed cotton yield plant^{-1} were observed in treatment B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS (81.86 g). This indicates the significance of plant growth regulators in improving growth and yield attributes of cotton which ultimately reflected into increased seed cotton yield plant^{-1}. This findings is conformity with Patel (1993), Deshpande and Lakhdive (1994) Hayat *et al*. (2002) [12, 5, 9].

Interaction effect

Number of picked bolls plant^{-1} showed significant interaction effect of genotypes and bio stimulant. The interaction effect of PDKV-JKAL-116 (BG-II) genotype with bio stimulant spray @ 4mg litre^{-1} at 30, 45 and 60 DAS was significantly superior over other genotype and bio stimulant combination in respect of number of picked bolls plant^{-1}. Total number of bolls that a cotton plants bears at a maturity is an important yield component having the greatest impact on the yield. This character is greatly influenced by both by physiological and environmental factors. Foliar application of anacardic acid @ 4mg litre^{-1} have higher number of picked bolls plant^{-1}. The application of anacardic acid increased the boll set percentage, reduced the abscission and increased the boll retention percentage which in turn helped in getting higher yield of seed cotton. This results are in conformity with Patel (1993), Pothiraj *et al*. (1995) and Sawan *et al.* (1998) [12, 14, 16] Average boll weight (g) was not significantly influenced due to interaction between genotypes and different bio stimulant spray at all the stages of crop growth. The data related to interaction effect between genotypes and different bio stimulants on seed cotton yield plant^{-1} of cotton as influenced by different treatments are presented in Table 16. Seed cotton yield plant^{-1} showed significant interaction effect of genotypes and bio stimulant. The interaction effect of PDKV-JKAL-116 (BG-II) genotype with bio stimulant spray @ 4mg litre^{-1} at 30, 45 and 60 DAS was significantly superior over other genotype and bio stimulant combination in respect of seed cotton yield plant^{-1}.

Table 2: Interaction effect of different genotypes and bio stimulants on seed cotton yield plant^{-1} (g)

Factor	V1	V2	Mean	Anova	SE (m) ±	CD 5%
B1	172.75	123.96	148.36	Genotype	2.22	6.73
B2	139.42	108.53	123.97	Bio stimulant	3.14	9.52
B3	125.82	89.88	107.85	V x B	4.44	13.47
B4	106.05	87.68	96.86			
Mean	136.01	102.51				

The major factor attributed for difference in the yield of seed cotton are the yield components *viz*., boll weight, number of bolls plant^{-1}, average boll weight and average seed weight. The growth regulators are capable of redistributing the dry matter in the plant thereby bringing about an improvement in the yield. Several authors also reported increase in seed cotton yield due to growth regulators application Deshpande and Lakhdive (1994), Hayat *et al*. (2002) and Ahmed *et al.* (2013) [5, 9, 1].

Table 3: Seed cotton yield, lint yield, cotton stalk yield, biological yield and harvesting index influenced by various treatments

Treatment	Seed cotton yield (kg ha^{-1})	Lint yield (kg ha^{-1})	Cotton stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Factor A–(Variety)					
V1 : PDKV JKAL- 116 (BG-II)	2275	809	4459	6734	33.78
V2 : AKH 9-5 (Suvarna Shubhra)	1725	612	4259	5945	29.01
SE(m) ±	50	11	109	2400	0.12
CD at 5%	152	33	NS	NS	NS
Factor B–(Application of bio stimulants)					
B1 : Anacardic acid @ 4mg litre^{-1} at 30,45 and 60 DAS	2256	809	4658	6914	32.62
B2 : Anacardic acid @ 4mg litre^{-1} at 45, 60 and 75 DAS	2068	729	4434	6502	31.80
B3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	1962	699	4307	6269	31.29
B4 : Water spray at 30, 45, 60 and 75 DAS	1714	607	3958	5672	30.21
SE (m) ±	71	16	154	3393	0.17
CD 5%	215	48	468	NS	NS
Interaction (A X B)					
SE (m) ±	102	21	218	4799.13	0.23
CD 5%	300	66	NS	NS	NS
GM	2000	711	4339	6339	31

The data pertaining to seed cotton, lint, cotton stalk, biological yield (kg ha^{-1}) and harvest index as influenced by various treatments (Table 3).

Effect of Variety

The seed cotton and lint yield (kg ha^{-1}) was significantly highest in genotype V_1 *i.e* PDKV JKAL–116 (2275 and 809 kg ha^{-1}) fallowed by genotype V_2 *i.e* AKH 9-5 (Suavarna Shubhra) (1725 and 612 kg ha^{-1}). This might be due the more yield potential of Bt cotton hybrids over non Bt variety. The cotton stalk and biological yield and harvest index (%) of cotton did not significantly influenced by different genotypes.

Effect of Bio stimulants

The seed cotton, lint and cotton stalk yield (kg ha^{-1}) was significantly highest *i.e* 2256, 809 and 4658 kg ha^{-1} respectively in treatment B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30, 45 and 60 DAS which was found significantly superior over B_3 *i.e* DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS (1962 kg ha^{-1}) and B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS (1714 kg ha^{-1}). However B_1 *i.e* Anacardic acid @ 4 mg litre^{-1} at 30, 45 and 60 DAS was found at par with B_2 *i.e* Anacardic acid @ 4 mg litre^{-1} at 45, 60 and 75 DAS (2068 kg ha^{-1}). This may be ascribed to the beneficial effect of Anacardic acid and DMSO as a growth regulator on physiology, growth of cotton which is ultimately reflected into increased seed cotton yield as reported by Patel (1992) [13]. It was conclude that with the low concentration of hormone and with more number of spray and vice versa was beneficial all the fibre parameters resulting in higher cotton yield this results were accordance with Yakhin *et al*. (2016) [20]. Spraying of different bio stimulant at different growth stages of crop did not significantly influenced the harvest index of cotton. However highest harvest index (%) was recorded in treatment B_1.

The data related to interaction effect between genotypes and different bio stimulants on seed cotton yield (kg ha-^{1}) of cotton as influenced by different treatments are presented in Table 4.

Table 4: Interaction effect of different genotypes and bio stimulants on seed cotton yield (kg ha-^{1})

Factor	V1	V2	Mean	Anova	SE (m)±	CD 5%
B1	2627	1885	2256	Genotype	50	152
B2	2376	1761	2068	Bio stimulant	71	215
B3	2182	1741	1962	V x B	102	300
B4	1914	1541	1714			
Mean	2275	1725				

V_1 *i.e* PDKV JKAL–116 genotype with B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30, 45 and 60 DAS combination recorded maximum seed cotton yield *i.e* 2627 kg ha^{-1} which was remain at par with treatment combination B_2 with V_1. Treatment B_1 *i.e* Anacardic acid @ 4mg litr litre^{-1} at 30, 45 and 60 DAS registered 24.02% yield increase as compare to control B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS. In cotton, the seed cotton yield depends on the accumulation of photo assimilates and partitioning of these in different parts of the plant. The seed cotton yield was strongly influenced by the application of different growth regulators indicating the role of these chemicals in increasing the seed cotton yield though their effect on various morpho-physiological and biochemical traits. Similar findings were also reported by Ahmed *et al.* (2013) [1]. V_1 *i.e* PDKV JKAL–116 genotype with B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30, 45 and 60 DAS combination recorded maximum lint yield *i.e* 945 kg ha^{-1} which was found significantly superior over other genotypes and bio stimulants spray. Cotton stalk and biological yield (kg ha^{-1}) was not significantly influenced due to interaction between genotypes and different bio stimulant spray at all the stages of crop growth.

Economics studies

The data regarding cost of cultivation influence due to various treatment of genotypes and bio stimulant are presented in table 5. The data shows that cost of cultivation was significantly influenced by different genotypes and bio stimulant.

Table 5: Cost of cultivation (Rs ha^{-1}), Gross monetary return (Rs ha^{-1}), Net monetary return (Rs ha^{-1}) and B:C ratio influenced by different treatments

Treatment	Cost of cultivation (Rs ha^{-1})	Gross monetary return (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	BC ratio
Factor A–(Variety)				
V_1 : PDKV JKAL- 116 (BG-II)	55020	137050	82030	2.49
V_2 : AKH 9-5 (Suvarna Shubhra)	50173	103942	53770	2.07
SE(m) ±	-	3017	3017	-
CD at 5%	-	9151	9151	-
Factor B–(Application of bio stimulants)				
B_1 : Anacardic acid @ 4mg litre^{-1} at 30,45 and 60 DAS	56844	135908	79064	2.38
B_2 : Anacardic acid @ 4mg litre^{-1} at 45, 60 and 75 DAS	53592	124617	71025	2.31
B_3 : DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS	53440	118190	64750	2.21
B_4 : Water spray at 30, 45, 60 and 75 DAS	50509	103269	52760	2.04
SE (m) ±	-	4267	4267	-
CD 5%	-	12942	12942	-
Interaction (A X B)				
SE (m) ±	-	8533	8533	-
CD 5%	-	NS	NS	-
GM	53263	120496	70015.5	2.28

Effect of variety

Maximum cost of cultivation (55020 Rs ha^{-}) and B:C ratio (2.49) was registered in V_1 *i.e* PDKV JKAL–116 than V_2 *i.e* AKH 9-5 (Suavarna Shubhra) cost of cultivation (50173 Rs ha^{-1}) and B:C ratio (2.07). Variety this was due to more cost of Bt seeds and higher seed cotton yield which requires more labour for cotton picking. Significantly higher gross monetary returns (137050 Rs ha^{-1}) and net monetary returns (82030 Rs

ha^{-1}) was registered in V_1 *i.e* PDKV JKAL–116) than V_2 *i.e* AKH 9-5 (Suavarna Shubhra) gross monetary returns (103942 Rs ha^{-1}) and net monetary returns (53770 Rs ha^{-1}) variety. Similar findings reported by Pothiraj *et al*. (1995) [14].

Effect of Bio stimulant

Cost of cultivation also influenced by the spray of different bio stimulant. Highest cost of cultivation (52844 Rs ha^{-1}) and B:C ratio (2.38) was observed in B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30, 45 and 60 DAS due to higher cost of bio stimulant and also due to increased yield which requires more labour for cotton picking as compare to other treatment, however it was found less cost of cultivation (50509 Rs ha^{-1}) and B:C ratio (2.04) in control. B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS) because of no cost of any plant growth regulator.

Gross monetary returns and net monetary returns was also influenced by the spray of different bio stimulant. Highest gross monetary returns (135908 Rs ha^{-1}) and net monetary returns (79064 Rs ha^{-1}) was found in B_1 *i.e* Anacardic acid @ 4mg litre^{-1} at 30,45 and 60 DAS fallowed by B_2 *i.e* Anacardic acid @ 4mg litre^{-1} at 45, 60 and 75 DAS then B_3 *i.e* DMSO 100 µl litre^{-1} at 30, 45, 60 and 75 DAS and lowest gross monetary returns (103269 Rs ha^{-1}) and net monetary returns (52760 Rs ha^{-1}) was observed in control B_4 *i.e* Water spray at 30, 45, 60 and 75 DAS. Highest GMR in treatment B_1 *i.e* Anacardic acid @ 4mg^{-1} at 30, 45 and 60 DAS was due to high seed cotton yield of that treatment. Highest production reflected in higher gross and net monetary returns. Similar findings reported by Singh *et al*. (1997) [17]. The data regarding interaction effect between the genotypes and different bio stimulant with respect to the gross and net monetary returns was found to be non-significant.

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